# The Science of Climate Change: Risks and Impacts

**Presentation to Connecticut Global Climate Change Summit: Business Risks and Opportunities for Connecticut's Insurance Industry**




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# Acknowledgements


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  - 50-year insurance veteran
  - President Emeritus, IBHS
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    - Property Insurance Plans Service Office
  - Fmr. President of the Massachusetts Automobile and Workers Compensation Rating Bureaus & The Earthquake Project
- Richard Roth, Jr.*
  - Fmr. California Assistant Insurance Commissioner ('84-'90)
  - Frm. P&C actuary in California, 20 years
  - Active in NAIC
  - Expert witness on catastrophe issues
- Paul Epstein, MD**
  - Harvard Medical School (Ctr. Hlth. Global Env.)
  - Leader Climate Change Futures study

• Research sponsors
  - U.S. Department of Energy
  - U.S. Environmental Protection Agency
  - U.S. Agency for International Development
  - UNDP • Swiss RE • Ceres

* Ceres White Paper

** Climate Change Futures Study

# Why Insurance & Climate Change?

- World's largest industry: $3+ *trillion*/year [3rd lg'st country]
- Prime mechanism for risk *averaging* (financial) & risk *management* (physical)
- Long-term role in consumer welfare and development ("emerging markets") -- if available & affordable
- Provides a global "observing" system [loss data]
- Insurance perspectives and tools complement "hard" science
  - Copes better with uncertainty
- The industry is vulnerable to climate change; Also a potential player in solutions

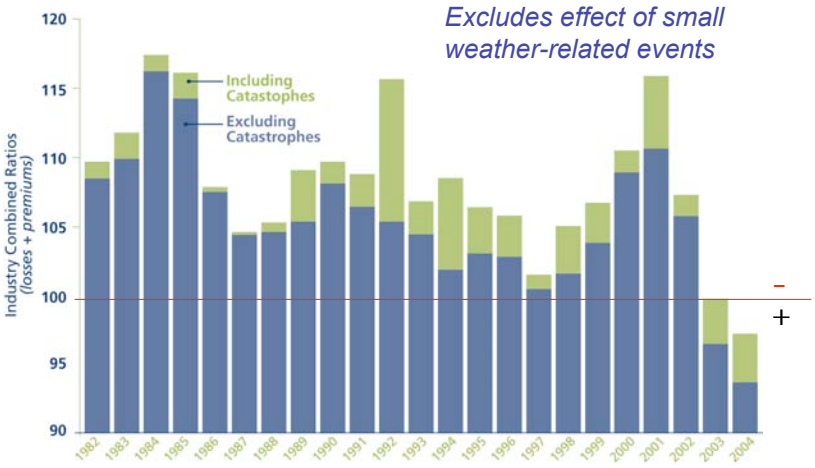
# Effected Business Segments

- Most direct lines + Reinsurance [P/C & L/H]
  - Homeowners, commercial multi-peril, business interruption, auto (personal/commercial), inland marine, aviation, crop, offshore energy, equipment breakdown, liability (several forms), life/health
- Surplus lines
- Guaranty Funds
- Residual Markets
- Risk Retention Groups
- ART

*and*… public-sector insurance programs

*Emerging Markets are a major "hotspot"*

# CATs Play Key Role in Profitability
# P&C Combined Ratios: 1982-2004

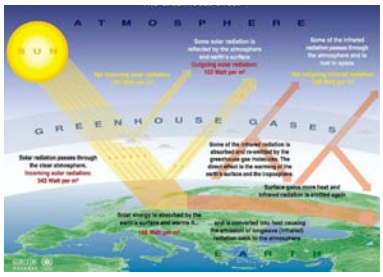



Source: AM Best, Aggregates & Averages

# The Greenhouse Effect

**Influences: Natural**
- Solar activity
- Volcanoes
- Biological

**Influences: Human**
- Fossil fuels
- Agricultural burning
- Deforestation
- Desertification
- Aircraft contrails




*Feedbacks can compound or dampen the effect*

**Impacts**
- Air & water temperatures
- Ice
- Precipitation
- Soil moisture
- Ocean currents
- Sea level
- Permafrost
- Ecosystems
- Weather
  - Averages
  - Extremes
  - Storm tracks
  - ENSO
  - Monsoons

## Climate change leads to a range of important impacts

**Climate Changes**

°F Temperature

Precipitation

Sea Level Rise

**Health Impacts**
Weather-related mortality/heat stress
Infectious diseases
Air quality-induced respiratory effects

**Agriculture Impacts**
Crop yields and commodity prices
Irrigation demands
Pests and weed

**Forest Impacts**
Change in forest composition
Shift geographic range of forests
Forest health and productivity

**Water Resource Impacts**
Changes in water supply and timing
Water quality
Increased competition for water

**Coastal Area Impacts**
Erosion of beaches
Inundation of coastal wetlands
Costs to defend coastal communities

**Ecosystem Impacts**
Shifts in ecological zones
Loss of habitat and species
Coral reefs threatened

**Beware of stovepipe assessments that miss interactions and correlations [H. Ivan --> Soybean Rust]**

## The Scientific Consensus

**Intergovernmental Panel on Climate Change WGII Plenary/Geneva 2001**

Operated by the UN: WMO and UNEP

In our fourth 5-year cycle of review and synthesis of scientific literature

- 1300 Authors; 1100 Expert Reviewers
- Findings unanimously adopted by 100+ nations

# National Academies of Science Declaration

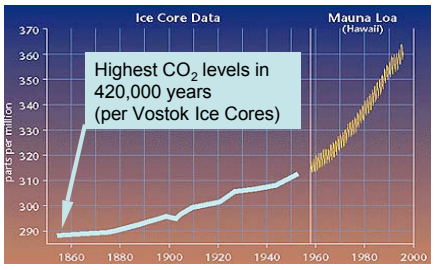
*We urge all nations … to take prompt action to reduce the causes of climate change.*

| | |
|---|---|
| Brazil | Italy |
| Canada | Japan |
| China | Russia |
| France | United Kingdom |
| Germany | United States of America |
| India | |

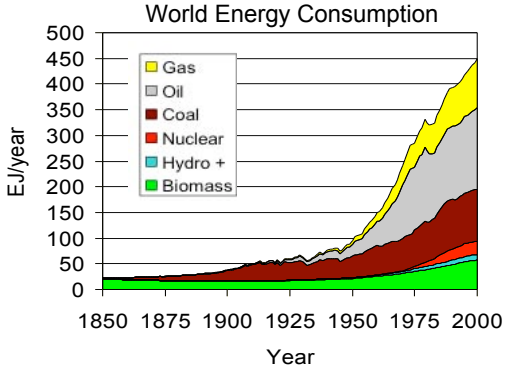
# Human Influence

- **Observed climate-change phenomena are consistent** with the predictions of climate science for human-caused GHG-induced warming
- **No alternative "culprit" identified** so far – no potential cause of climate change other than greenhouse gases – yields this "fingerprint" match
- **A credible alternate theory would need to explain** both what the alternative cause of the observed changes is and how it could be that GHGs are NOT having the effects that all current scientific understanding says they should have

World Carbon Dioxide Concentrations

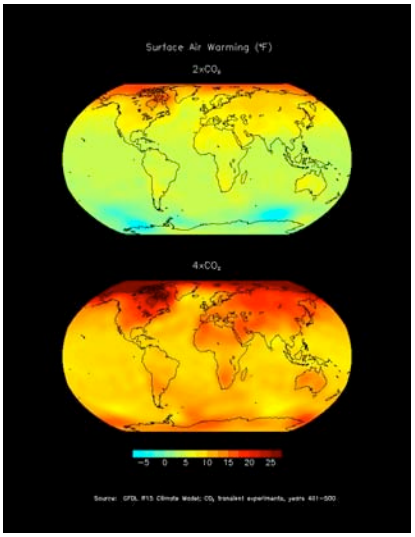



World Energy Consumption



# We'll pass the 2x$CO_2$ Milestone ~2050

Air Temperatures

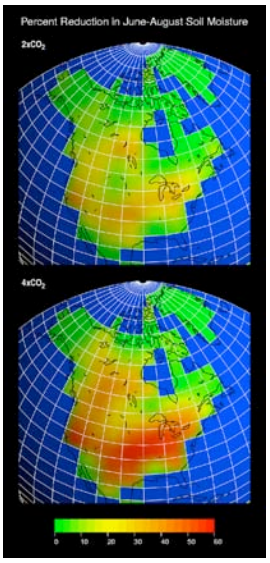



2x $CO_2$

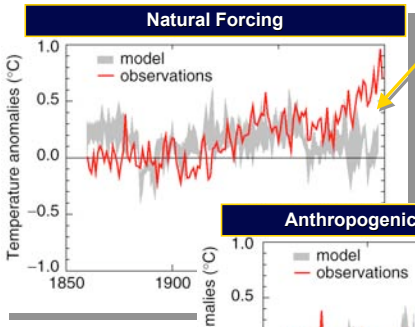
4x $CO_2$

**With increased warming, net impacts increasingly negative**

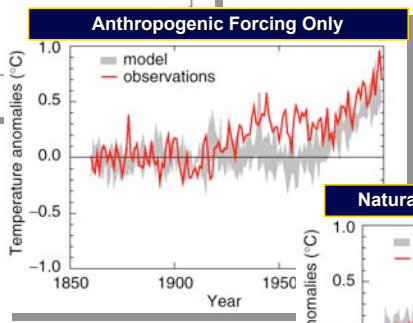
Soil Moisture




Source: NOAA (Geophysical Fluid Dynamics Laboratory)

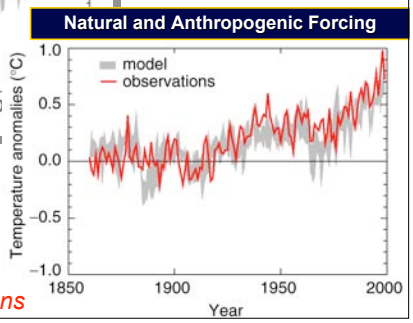



• Natural (solar + volcanic) forcing alone does not account for warming in the past 50 years.




• human influences alone (greenhouse gases and sulfate aerosols) brings the models and observations into pretty good agreement.

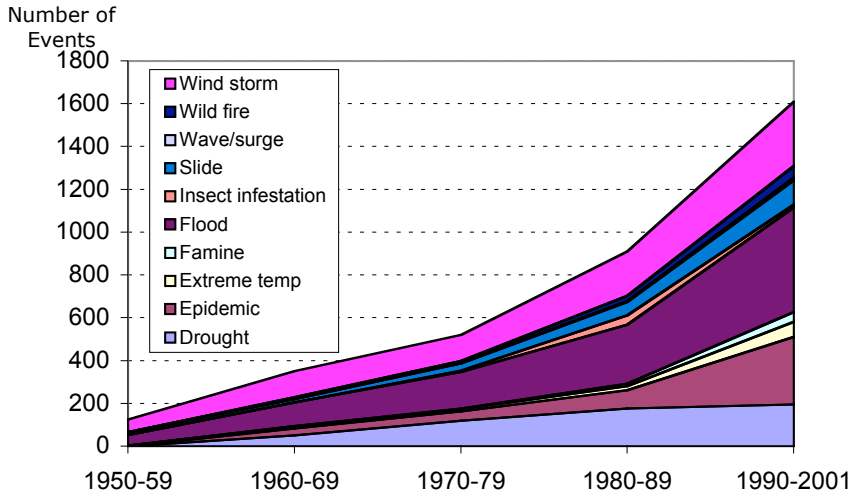
**Fingerprint:** Temperatures higher than in past 1000 years, and increasing at fastest rate over this period




**Prime cause of observed warming is human activity (IPCC 2001)**

*"Warming Commitment" is even greater: Most of warming temporarily locked in the oceans*

# Fingerprint: Rise in Number and Change in Mix of Weather/Climate Disasters



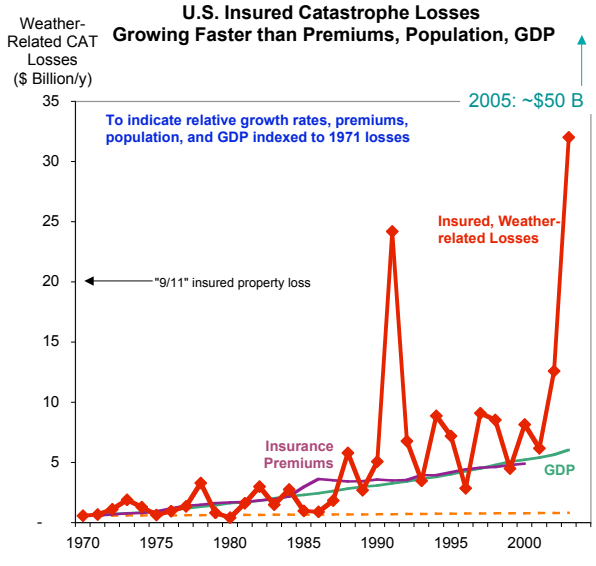

Source: Center for Research in the Epidemiology of Disasters (CRED)

# Uncertainty: Physical ➡ Financial

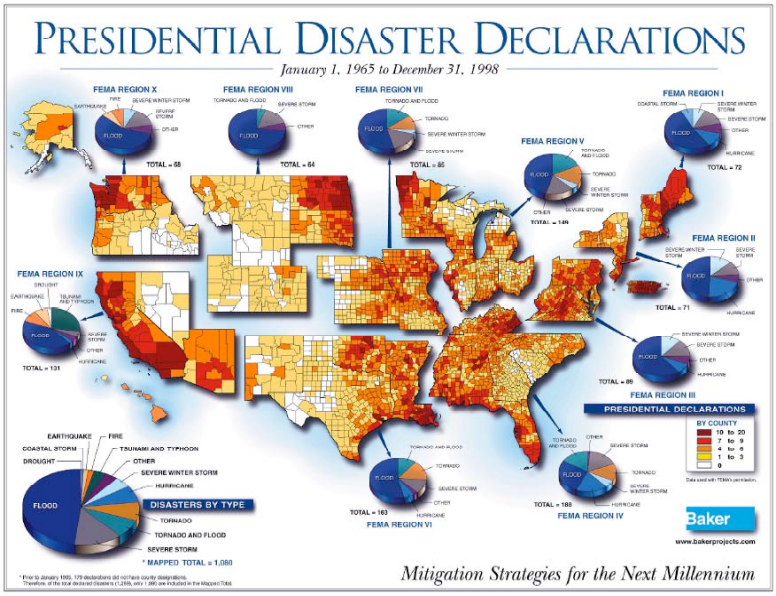
**"Catastrophe insurers can't simply extrapolate past experience."**

***- Warren Buffett*** *(1992)*

- **Non-climate factors are key**
- **Trend consistent with observed climate changes**
- **Without prevention, losses would have been higher; same for changes in terms**
- **Only large events included: excludes**
  - **some property losses**
  - **health/life losses**
  - **small-scale events**
- **Variability is increasing**



# Disasters Not Just a "Coastal" Issue




# Small-scale, Gradual, Diffuse, and Indirect Events Often Overlooked

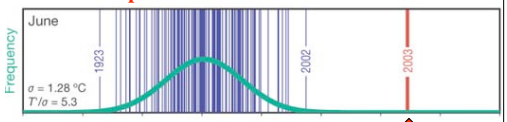
- Blackouts
- Crop damages
- Drought
- Equipment breakdown
- Eroded air quality
- Eroded water quality
- Hail
- Ice Storms
- Infectious diseases
- Lightning
- Mudslides
- Sea-level rise/Coastal erosion
- Sinkholes
- Subsidence
- Thunderstorms
- Tornados
- Vehicle damages/injuries
- Wildfire
- Winterstorms

# Health Impacts

- **Human Systems**
  - Heat stress
  - Respiratory disease
    - Pollen
    - Mold
    - Smoke and particulates
  - Food poisoning
  - Infectious diseases
  - Water quality
  - Injury/death from catastrophes and small-scale events
  - Contamination

- **Natural Systems**
  - Crops & livestock
  - Coral reefs
  - Forest health
  - Biodiversity

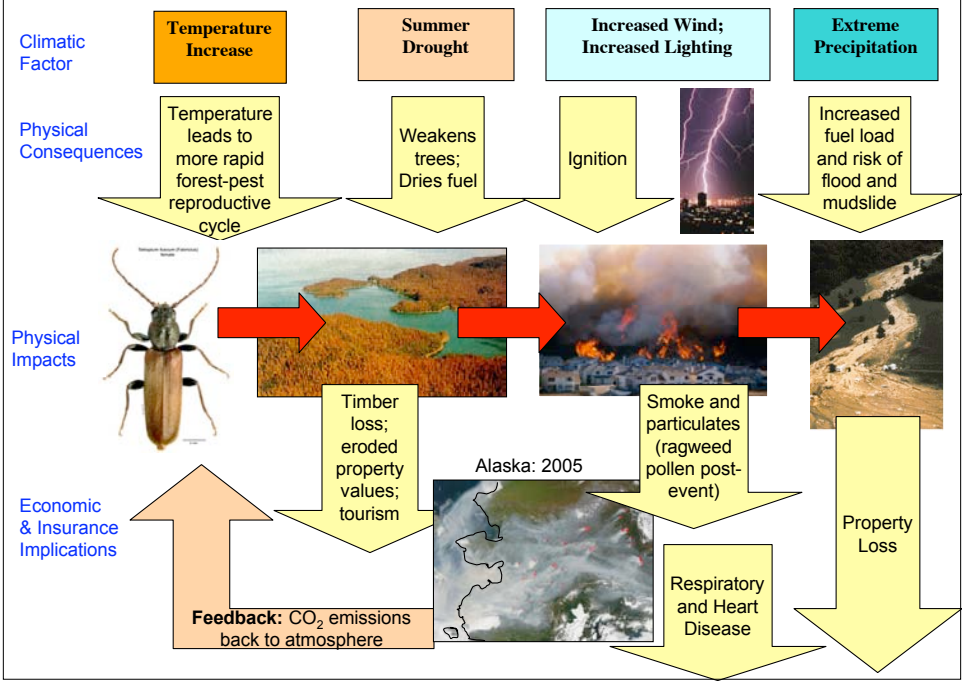
**The European heat wave of Summer 2003.**




Event was "six-sigmas" outside of norm. 16°F above average in France and Germany was a 1-in-10,000 event to 1-in-46,000 event

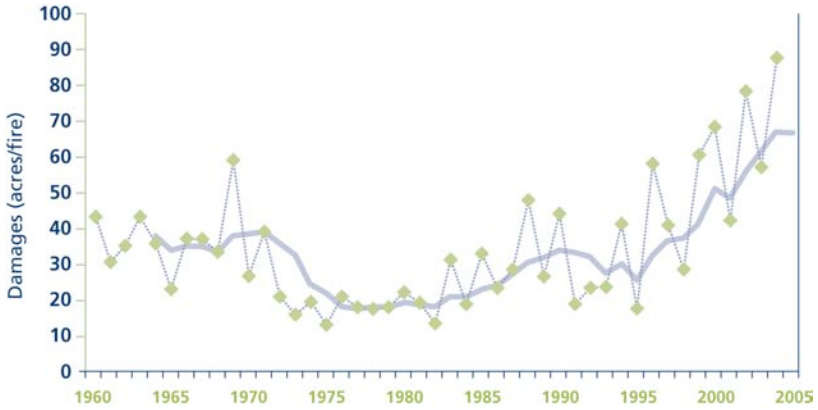
*WHO estimates 150,000 human mortalities each year due to current climate change*

**CLIMATE CONNECTIONS: The Example of Wildfire • Severity to increase 2x to 4x**



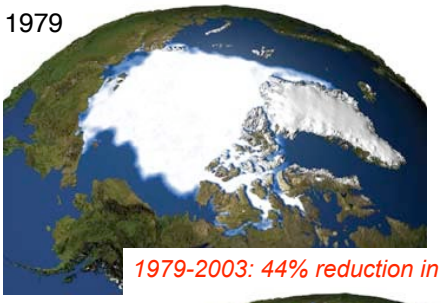
# Fingerprints: Wildfire

(acres burned per fire: U.S. 1960-2004)



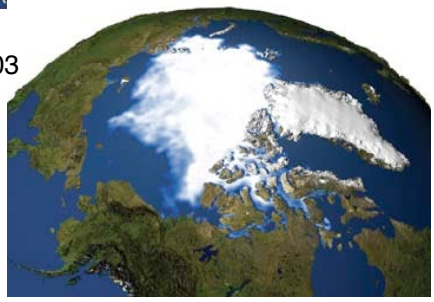

# Fingerprint: Loss of Ice & Snow Cover

1979



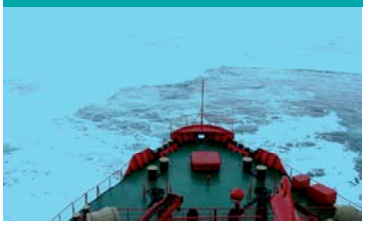
*1979-2003: 44% reduction in thickness*

2003



- Loss of land ice contributes to sea-level rise
- "Darkens" Earth's surface [undesirable feedback]
- "Freshens", cools northern oceans
- Collateral permafrost melt

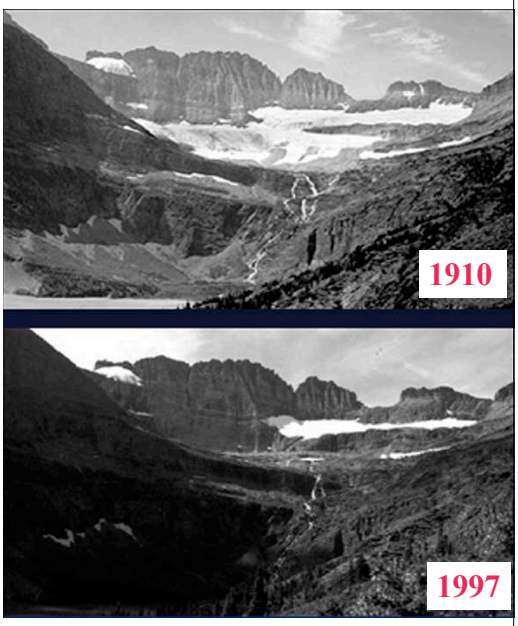
**90 deg N**
**August 7, 2004**
**Harvard University expedition to North Pole**



# Fingerprint: Worldwide Glacier Retreat

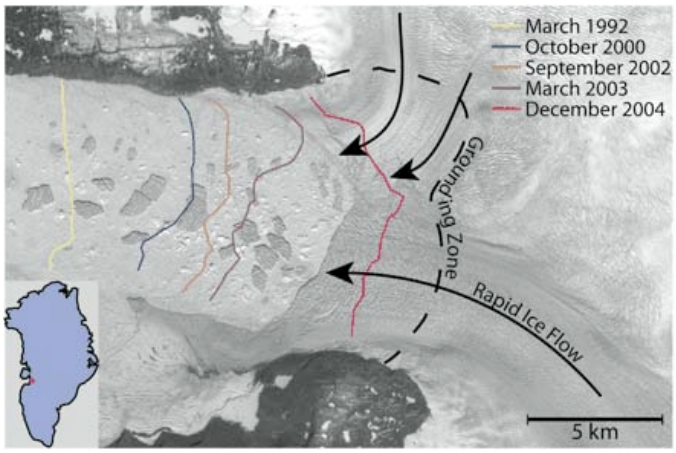
Americas
Europe
Asia
Africa
Australasia

*Grinell Glacier, "Glacier" National Park, USA*



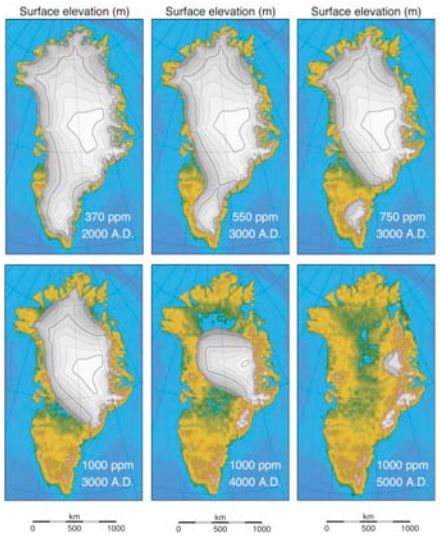

# Fingerprint: Melting Land Ice

Near complete disintegration of Jackobshavn Isbrae, Greenland's largest outflow glacier




Alley *et al.*, *Science* (21 October 2005) -- Landsat

# The Greening of Greenland

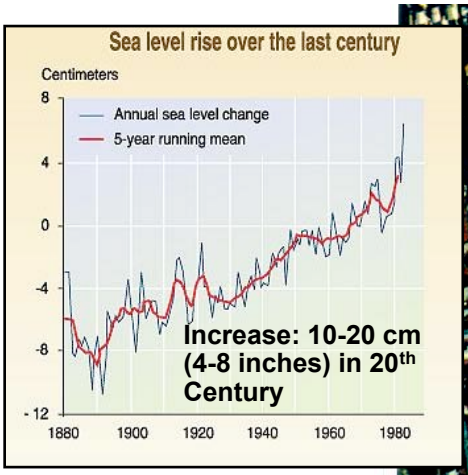


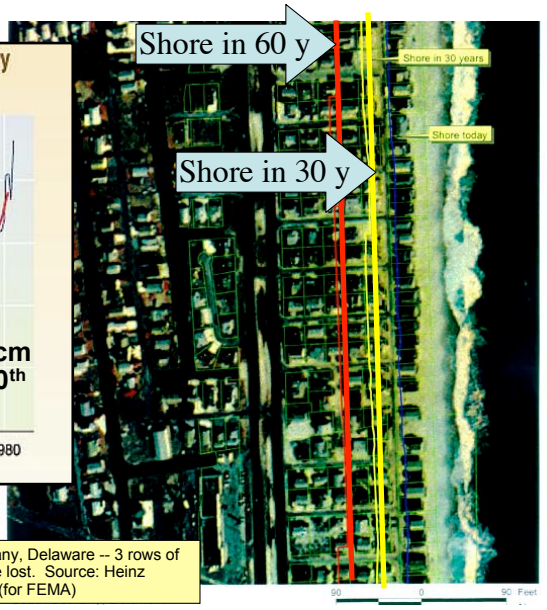

Source: Alley et al. *Science* (21 October 2005)

**Meltwater "freshens" the oceans, *contributing* to climate change**

# Florida under 4m Sea-level Rise

# Fingerprint: Sea Level Rise

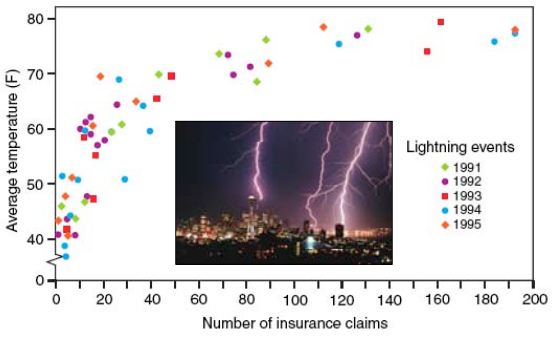



South Bethany, Delaware -- 3 rows of homes to be lost. Source: Heinz Foundation (for FEMA)

# Fingerprint: Lightning

Lightning-related claims *accelerate* with temperature




Source: Hartford Steam Boiler Inspection and Insurance Co.

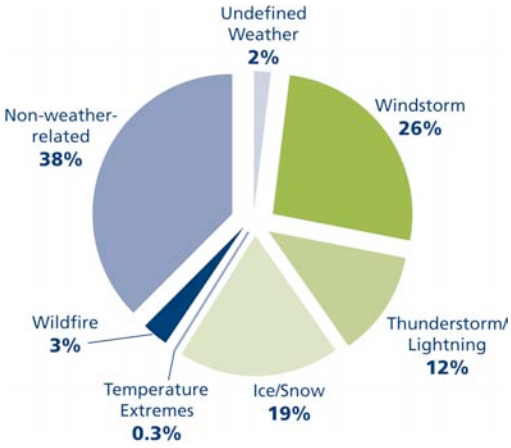
**Examples of Losses:**

- Half of wildfires in western US
- >3000/year: structural and vehicle fires
- 30% of power outages
- 80% of petroleum storage accidents
- 346 incidents to 81 nuclear sites: 1990s
- $2B/year: airline operating costs
- 100,000/y: desktop computer losses
- Traffic signal outages
- $1B/year insurance claims (1989)
- State Farm: 300k claims/year, $330M
- Factory Mutual: 3-4% of claims

Source: www.lightningsafety.com

# Power Outages

**Bulk Power Disturbances:**
**52 million customers (1982-2002)**




**Power outages were a factor in slowness of draining New Orleans following Katrina. Also important for contingent business interruption.**

U.S. total ~$80B/year

*Current insured portion unknown: most are below ISO/PCS threshold for being "worth" counting.*

## Dynamics of Risks, Uncertainties, and Losses

Natural Phenomenon

*(e.g. temperature increase)*

Variability/Uncertainty

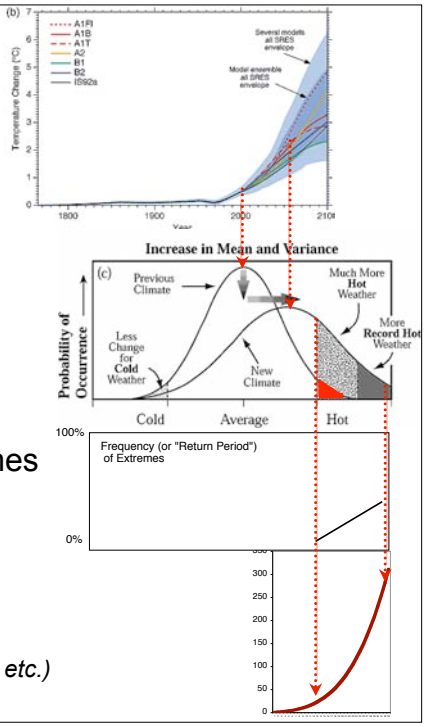
*(e.g. temperature extremes)*

Change in Likelihood of Extremes

*(e.g. return period of heat waves)*

Impact / Insured Loss

*(e.g. loss of life; business interruption, etc.)*



# Why Worry?

- Underwriting
  - Compounds existing insurance problems
    - Mold, Respiratory Disease, Corporate Governance/Liability…
  - Shorter return periods; Increasing variability
  - New types of (unanticipated) losses; changing location
  - "Cat-following-Cat" (windstorm and flood)
  - Unexpected correlation (power outage ⟺ flood)
  - Increases not necessarily predictable or gradual
  - Profitability/solvency
  - Flying (partly) blind
    - Seriously incomplete, and increasingly proprietary loss data
      - Have to go to Switzerland or Germany to get good public-domain US data!
    - Financial and physical CAT models based on past outcomes have limited forward-looking value

# Why Worry? (cont'd)

- Asset Management
  - Financial market conditions
  - Real estate holdings
- Operations Management
  - Ability to function in post-disaster settings
- Market Power
  - Slowed or shrinking market
    - shift from U.S. to Europe/Asia -- where foresight is greater?
    - voluntary - withdrawal
    - involuntary - knock-on effects
  - Reputation risk
- Indirect Effects
  - "Dust-bowl plus Depression" syndrome
  - Escalating energy prices & inflation bad for insurance market
  - Impacts of climate change on insurance customers

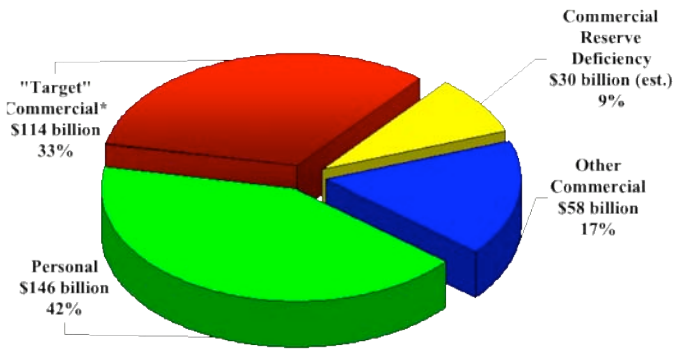
***The future that will not mirror the past***

# Response Options

- Reactive (terms & conditions)
  - Higher premiums
  - Higher deductibles
  - Lower limits
  - Exclusions
  - Non-renewal
  - Withdraw from markets
- Proactive (loss prevention)
  - Building codes & land-use planning
  - Disaster preparedness, recovery, education
  - Improved modeling
  - Reducing the causes of climate change
    - Underwriting
    - Asset Management
    - Operations

# Capital Myth: $400 Billion Available to Pay Losses

**Climate change is not priced into the market**




Surplus not pooled across companies or lines of business. Must also back-up non-disaster related property/casualty claims and non-weather claims (e.g., terrorism).
Surplus fluctuates: sometimes significantly - partly weather-sensitive

Source: Insurance Information Institute estimates based on A.M. Best Q.A.R Data. (Robert Hartwig, III)

## Problems ⇒ Opportunities

*The insurance sector has a key role to play in helping to mitigate the effects of climate change by providing financial indemnification, compensation and relief against climate change events and by developing new products and solutions that can support emerging GHG [greenhouse gas] and renewable energy markets.*

Marsh & McLennan Companies

## Regulatory Considerations

*It has become evident that climate change will continue to challenge insurers and state insurance regulators. Inevitably, this will pose a threat to the availability of essential insurance coverage for consumers.*

NAIC (2005)

- Consumers
  - Availability
  - Affordability
  - Solvency
- Insurers
  - Data, models…
  - Disclosure
  - Overseas risk
  - Barriers to innovation

# Regulators Can Play a Decisive Role

*Reinsurers who provide a backstop on large losses are engaged on the climate issue, but much more work needs to be done by the primary insurers who consumers rely on when catastrophes hit.*

Joe Ario, Oregon Insurance Administrator
Vice President, National Association of Insurance Commissioners (2005)

*After New Orleans, it's becoming clearer that we are experiencing more frequent and more powerful weather events that pose huge challenges for the insurance industry. … This is both a coastal issue and a heartland issue.*

Tim Wagner, Director Nebraska Department of Insurance (2005)

***"Everybody talks about the weather, but nobody does anything about it."***

*-- Charles Dudley Warner*
*Hartford Courant (1897)*

# More Information

**http://eetd.lbl.gov/insurance**

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# Source Material

- Primary Sources: *Science* magazine, *Nature* magazine, Munich Re, Swiss Re, Insurance Information Institute; PCS/ISO
- United Nations / World Meteorological Organization -- Intergovernmental Panel on Climate Change
- John P. Holdren. Presentation to 2003 UN Investors Summit entitled "Risks from Global Climate Change: What Do We Know? What Should We Do?"
- Paul Epstein, M.D., M.P.H., Harvard Medical School, Center for Health and the Global Environment, presentation entitled "Climate Change Futures" Study (Swiss Re and UNDP)

# Supplementary Materials